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**PARASITIC DISEASES OF MONKEYS IN OSUN STATE, NIGERIA: A  
TEN-YEAR RETROSPECTIVE STUDY OF OCCURRENCE, RISK  
FACTORS AND COINFECTION DYNAMICS**

**Shola D. Ola-Fadunsin<sup>\*1</sup>, Nathan A. Furo<sup>2</sup>, Isaac D. Olorunshola<sup>3</sup>, Deborah A. Adah<sup>2</sup>  
and Olubukola Aluko<sup>4</sup>**

<sup>1</sup>Department of Veterinary Parasitology and Entomology, <sup>2</sup>Department of Veterinary Medicine, and <sup>3</sup>Department of Veterinary Microbiology, Faculty of Veterinary Medicine, University of Ilorin, Ilorin, Nigeria and <sup>4</sup>Veterinary Services Division, Osun State Ministry of Agriculture and Food Security, Osogbo, Osun State, Nigeria.

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**ABSTRACT**

*This study profiled the parasitic diseases diagnosed in monkeys that were presented at the Zonal (Government) Veterinary Clinics at Osogbo, Ilesa, Ede and Ikirun in Osun State over a ten year period (2006 - 2015). Information retrieved from the databases of the clinics included the age, gender, date of presentation of the monkey at the clinic as well as the specific parasitic disease(s) diagnosed. A total of eight parasitic diseases including helminthosis (83.10%), babesiosis (33.80%), tick infestation (32.39%), lice infestation (16.90%), mange (15.49%), flea infestation (11.27%), myiasis (4.23%) and trypanosomosis (1.41%) were diagnosed in monkeys during the period. Age was a common risk factor associated with the occurrence of the parasitic diseases diagnosed. Approximately 76% of the studied animal species were cases of multiple parasitic infestations running through age groups, gender and seasons. Babesiosis was moderately and positively correlated with tick infestation and the association was significant ( $P = 0.01$ ;  $r_s = 0.587$ ). Some of the parasitic disease conditions reported in this study are zoonotic. This study creates awareness on zoonoses and serves as a referenced document for veterinarians, medical practitioners, researchers and monkey owners/handlers. It is therefore recommended that people should exercise caution and maintain proper hygiene in their relationship with wild captive animals to reduce the risk of transmission of infections between animals and man. Public education and awareness on the possible zoonosis from such wild captive animals and the periodic screening and treatment of such animals and in-contact individuals may be useful in controlling the parasites*

**Keywords:** Monkeys, Parasitic diseases, Risk factors, Zoonoses, Osun State, Nigeria

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## INTRODUCTION

The type of monkeys found in Africa are referred to as the Old World monkeys (*Catarrhini*) and apes (*Hominoidea*) [1]. They are the most common groups of animals in zoological gardens due to their role in public entertainment [2,3]. Among all captive-held wild animals, monkeys are kept for various purposes including education, entertainment, relaxation, research, cultural, transportation, labour, and preservation of endangered species and as pets [4].

Parasitism exerts greatly on the reproduction, performance and total well-being of animals including those in captivity [5,6,7]. Haemoprotozoan parasites which include species of *Plasmodium*, *Leishmania*, *Trypanosoma*, *Hepaticystis* and *Babesia* infect various species of monkeys in most parts of the world [5,8]. Monkeys are also known to be afflicted with different gastrointestinal parasites ranging from helminths (*Ancylostoma*, *Ascaris*, *Capillaria*, *Controrchis*, *Strongyle*, *Strongyloides*, *Trichuris*, and *Trypanoxyuris*) to protozoan species (*Eimeria* and *Entamoeba*) [3,4,6,9,10]. Ectoparasites such as ticks, fleas and mites have also been encountered on monkeys in most parts of the world [11,12,13,14].

Generally parasitism causes a whole lot of conditions in animals including monkeys. The conditions include gastro-enteritis, haemorrhage, anaemia, extra-intestinal infection, spontaneous abortion, pruritus, shin wounds, pica, diarrhea, anorexia, weight loss, unthriftiness and even death [3,4,7,15].

The increasing use of monkeys as pets and for research has resulted in increased contact between monkeys and man. Consequently, there is need to evaluate the parasitic diseases that affect monkeys, especially those that may be zoonotic, so as to provide reference data and add to already existing information for veterinarians, medical practitioners, researchers and monkey owners/handlers.

## MATERIALS AND METHODS

### Study area

The study was conducted in the Zonal Veterinary Clinics at Osogbo, Ilesa, Ede and Ikirun, which are the major cities in Osun State. Osun State is located in the south western part of Nigeria and lies between latitude 7° 59'N and longitude 4° 56'E. Osun State is characterized by tropical dry and wet climate with lowland tropical rain forest vegetation. The dry season occurs in a 5 month period between November and March while the wet season covers a 7 month period from April to October [16]. The State is bordered in the north by Kwara State, in the east partly by Ekiti State and partly by Ondo State, in the south by Ogun State and in the west by Oyo State. The State has a mean annual rainfall of between 127.77 cm and 159.76 cm and an average annual temperature ranging from 21.1 °C to 31.9 °C. The minimum and maximum annual relative humidity are 58.7 % and 79.6 % respectively [16,17].

### Data collection and study design

A ten year (2006 – 2015) retrospective evaluation of parasitic diseases diagnosed in monkeys presented at the Zonal Veterinary Clinics in Osogbo, Ilesa, Ede and Ikirun was conducted. The records retrieved from the databases included; the age, gender and date of presentation of the monkeys to the clinic as well as the specific parasitic disease(s) diagnosed. Clinical assessment of the monkeys and the diagnosis of each parasitic disease were based on the case history, physical examination and the clinical symptoms manifested by the animals. Where necessary,

appropriate samples were collected and forwarded to the laboratory for confirmation of the clinical diagnosis.

Freshly deposited faecal samples or those collected directly from the rectum were examined by both sedimentation and saturated sodium chloride floatation techniques using the light microscope. Blood samples were collected through the cephalic vein into sample bottles containing EDTA as anticoagulant. Thin blood smears were routinely prepared, stained and examined microscopically. Skin scrapings were dissolved in 10% potassium hydroxide solution and the sediments examined using the stereomicroscope. All the laboratory procedures were routinely conducted and the parasites present identified based on their morphological characteristics as described by Soulsby [18].

### Data computation and Statistical analysis

Statistical evaluation was carried out using the Chi-square ( $\chi^2$ ) test to measure for significant association. The univariate analysis (Chi-square) test and odds ratios with 95% confidence interval were used to determine the association between each risk factor and the parasitic diseases with more than 20 cases (helminthosis, babesiosis and tick infestation). The odds ratios were calculated with respect to a reference category as indicated in the tables. Spearman's correlation was used to measure the strength of association for the parasitic diseases co-infection. The strength of association between parasitic conditions co-infection was measured as described by Mukaka [19]. All statistical tests were conducted using statistical package for social sciences (SPSS) version 22 (SPSS Inc., Chicago) and values of  $p < 0.05$  were considered significant.

## RESULTS

### Prevalence of parasitic diseases of monkeys

A grand total of 71 monkeys were diagnosed with parasitic diseases over the ten year period with helminthosis as the most prevalent (83.10%) followed respectively by babesiosis (33.80%), tick infestation (32.39%), flea infestation (11.27%), lice infestation (16.90%), mange (15.49%) and trypanosomosis (1.41%) (Fig. 1).

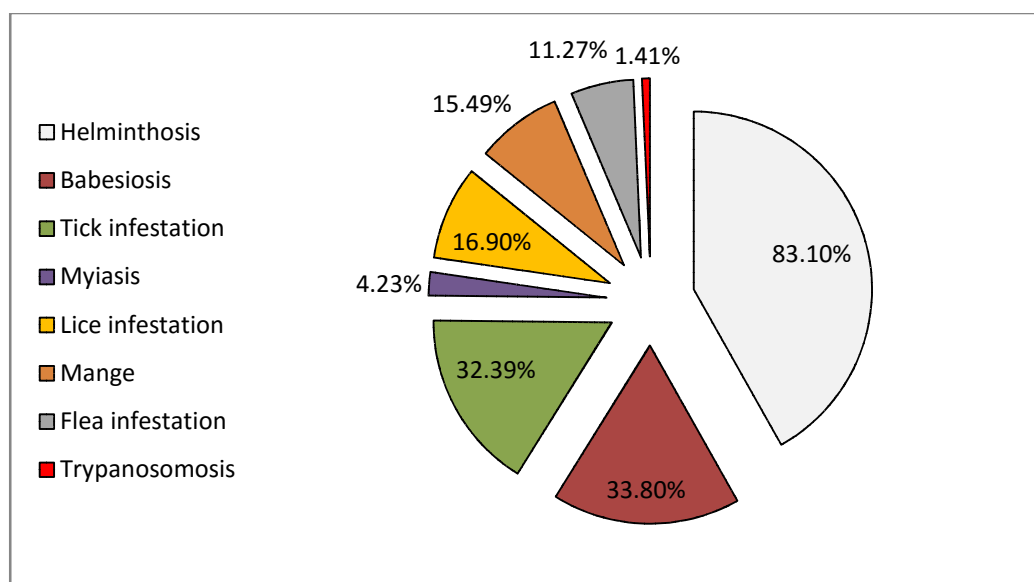


Figure 1. Prevalence of parasitic diseases of monkeys in Osun State, Nigeria (2006–2015).

### Risk factors for parasitic diseases in monkeys

Age was the only risk factor significantly ( $p < 0.05$ ) associated with the prevalence of helminthosis; young monkeys being about 7 times more likely to be infected than adult monkeys (Table 1). Age, gender and season were significantly ( $p < 0.05$ ) associated with the prevalence of babesiosis. Adult monkeys were more susceptible to babesiosis compared to the young, and babesiosis was more prevalent among female than male monkeys. The tick-borne disease was higher during the dry season than the wet season (OR = 3.87; 95% CI = 1.36 – 11.04;  $P = 0.01$ ) (Table 2). The association of age, gender and season with the prevalence of tick infestation is presented in Table 3. Age alone was significantly ( $P < 0.05$ ) associated with the disease while gender and season were not. Adult monkeys were 20.24 times more likely to be infested with ticks compared to young monkeys.

**Table 1. Prevalence and potential risk factors associated with helminthosis in monkeys in Osun State, Nigeria (2006-2015).**

| Variables          | Positive (%) | Negative (%) | Odds Ratio (95% CI) | P                 |
|--------------------|--------------|--------------|---------------------|-------------------|
| Age                |              |              |                     |                   |
| Young <sup>a</sup> | 23 (95.83)   | 1 (4.17)     | 1.00                |                   |
| Adult              | 36 (76.60)   | 11 (23.40)   | 0.14 (0.02– 1.18)   | 0.04 <sup>b</sup> |
| Gender             |              |              |                     |                   |
| Male <sup>a</sup>  | 37 (77.08)   | 11 (22.92)   | 1.00                |                   |
| Female             | 22 (95.65)   | 1 (4.35)     | 6.54 (0.79– 54.17)  | 0.05              |
| Season             |              |              |                     |                   |
| Wet <sup>a</sup>   | 37 (78.72)   | 10 (21.28)   | 1.00                |                   |
| Dry                | 22 (91.67)   | 2 (8.33)     | 2.97 (0.60 – 14.83) | 0.20              |

<sup>a</sup>Reference category, <sup>b</sup> Significant, CI=Confidence Interval.

### Coinfection dynamics of parasitic diseases of monkeys

Seventeen of the 71 monkeys infected by parasites had single parasitic condition, representing 23.94% of the population (Table 4). In this category, helminthosis (22.54%) and babesiosis (1.41%) were the only diseases diagnosed. In the two parasitic diseases coinfection; helminthosis + lice infestation was the most prevalent (15.49%), while babesiosis + myiasis was the least prevalent (1.41%). Of the three parasitic diseases coinfection; helminthosis + babesiosis + tick infestation was the most prevalent. On the other hand, helminthosis + babesiosis + tick infestation + trypanosomosis was the only four parasitic diseases coinfection encountered during the study (Table 4). The prevalence of parasitic diseases coinfection among the various epidemiological factors is presented in Table 5. Young monkeys were plagued with two (83.33%) and three (16.67%) parasitic diseases coinfection, while adults were plagued with all the four categories of parasitic diseases coinfection. Female monkeys had a higher prevalence of single, triple and quadruple parasitic diseases coinfection, while male had a higher prevalence of double coinfection. Higher prevalence of double, triple and quadruple parasitic diseases coinfection was recorded during the dry season as against the wet season when single, double and triple disease conditions were more prevalent.

### Correlation of parasitic diseases of monkeys

There was a moderate and negative correlation between helminthosis and babesiosis and this was statistically significant ( $p < 0.05$ ). The association between helminthosis and tick infestation was low, negative and of a significant relationship ( $p < 0.05$ ). Babesiosis was moderately and

positively correlated with tick infestation and the association was significant ( $P = 0.01$ ;  $r_s = 0.587$ ). Babesiosis had a low and negative association with lice infestation and mange respectively and the correlation was statistically significant at  $P = 0.01$ . A negative and negligible correlation was recorded between tick infestation and mange ( $r_s = -0.296$ ); myiasis and mange ( $r_s = -0.297$ ), with the association been significant ( $P < 0.05$ ).

**Table 2. Prevalence and potential risk factors associated with babesiosis in monkeys in Osun State, Nigeria (2006-2015).**

| Variables          | Positive (%) | Negative (%) | Odd Ratio (95% CI)   | P                  |
|--------------------|--------------|--------------|----------------------|--------------------|
| Age                |              |              |                      |                    |
| Young <sup>a</sup> | 1 (4.17)     | 23 (95.83)   | 1.00                 |                    |
| Adult              | 23 (48.94)   | 24 (51.06)   | 22.04 (2.75 – 76.82) | <0.01 <sup>b</sup> |
| Gender             |              |              |                      |                    |
| Male <sup>a</sup>  | 12 (25.00)   | 36 (75.00)   | 1.00                 |                    |
| Female             | 12 (52.17)   | 11 (47.83)   | 3.27 (1.15 – 9.32)   | 0.03 <sup>b</sup>  |
| Season             |              |              |                      |                    |
| Wet <sup>a</sup>   | 11 (23.40)   | 36 (76.60)   | 1.00                 |                    |
| Dry                | 13 (54.17)   | 11 (45.83)   | 3.87 (1.36 – 11.04)  | 0.01 <sup>b</sup>  |

<sup>a</sup>Reference category, <sup>b</sup> Significant, CI=Confidence Interval.

**Table 3. Prevalence and potential risk factors associated with tick infestation in monkeys in Osun State, Nigeria (2006-2015).**

| Variables          | Positive (%) | Negative (%) | Odd Ratio (95% CI)   | P                  |
|--------------------|--------------|--------------|----------------------|--------------------|
| Age                |              |              |                      |                    |
| Young <sup>a</sup> | 1 (4.17)     | 23 (95.83)   | 1.00                 |                    |
| Adult              | 22 (46.81)   | 25 (53.19)   | 20.24 (2.52 – 62.41) | <0.01 <sup>b</sup> |
| Gender             |              |              |                      |                    |
| Male <sup>a</sup>  | 16 (33.33)   | 32 (66.67)   | 1.00                 |                    |
| Female             | 7 (30.43)    | 16 (69.57)   | 0.88 (0.30 – 2.56)   | 0.82               |
| Season             |              |              |                      |                    |
| Wet <sup>a</sup>   | 16 (34.04)   | 31 (65.96)   | 1.00                 |                    |
| Dry                | 7 (29.17)    | 17 (70.83)   | 0.80 (0.27 – 2.32)   | 0.70               |

<sup>a</sup>Reference category, <sup>b</sup> Significant, CI=Confidence Interval.

## DISCUSSION

Helminthosis, babesiosis, tick infestation, myiasis, lice infestation, mange, flea infestation and trypanosomosis were the parasitic diseases diagnosed among monkeys during the period under consideration. Reports on helminth infections in monkeys has been documented previously in Nigeria [3,6,9] with no report on haemoparasitic and ectoparasitic infections in the studied species. A good number of helminths found in monkeys are zoonotic [3,9,10]. Tick infestation occurs commonly in monkeys, with *Haemaphysalis spinigera* being the predominant tick that affects the animal species and can also plague man [20,21]. Lice and flea infestations has been reported among monkeys (*Macaca fuscata*) in Japan [22]. *Babesia* and *Trypanosoma* parasites have been reported among monkeys in Madagascar [5] and Kenya [8]. Myiasis is an important ectoparasitic condition of monkeys, and one of the flies involved (*Cordylobia anthropophaga*) can also affect man [13]. Mange caused by *Sarcoptes scabiei* mites which is zoonotic was reported among monkeys in India [23].

**Table 4. Prevalence of parasitic diseases coinfection in monkeys in Osun State, Nigeria (2006-2015).**

| Number of Parasitic Diseases                                  | Number Positive (%) | 95% CI        |
|---------------------------------------------------------------|---------------------|---------------|
| <b>One</b>                                                    | 17 (23.94)          | 15.10–34.87   |
| Helminthosis                                                  | 16 (22.54)          | 13.95 –33.32  |
| Babesiosis                                                    | 1 (1.41)            | 0.07 – 6.75   |
| <b>Two</b>                                                    | 39 (54.93)          | 43.27 – 66.19 |
| Helminthosis + Babesiosis                                     | 5 (7.04)            | 2.63 – 14.92  |
| Helminthosis + Tick Infestation                               | 4 (5.63)            | 1.82 – 13.03  |
| Helminthosis + Lice Infestation                               | 11 (15.49)          | 8.43 – 25.33  |
| Helminthosis + Mange                                          | 8 (11.27)           | 5.37 – 20.27  |
| Helminthosis + Flea Infestation                               | 3 (4.23)            | 1.09 – 11.07  |
| Babesiosis + Tick Infestation                                 | 7 (9.86)            | 4.42 – 18.53  |
| Babesiosis + Myiasis                                          | 1 (1.41)            | 0.07 – 6.75   |
| <b>Three</b>                                                  | 14 (19.72)          |               |
| Helminthosis + Babesiosis + Tick Infestation                  | 6 (8.45)            | 3.50 – 16.75  |
| Helminthosis + Tick Infestation + Lice Infestation            | 1 (1.41)            | 0.07 – 6.75   |
| Helminthosis + Tick Infestation + Flea Infestation            | 1 (1.41)            | 0.07 – 6.75   |
| Helminthosis + Myiasis + Mange                                | 2 (2.82)            | 0.47 – 9.00   |
| Helminthosis + Mange + Flea Infestation                       | 1 (1.41)            | 0.07 – 6.75   |
| Babesiosis + Tick Infestation + Flea Infestation              | 3 (4.23)            | 1.09 – 11.07  |
| <b>Four</b>                                                   | 1 (1.41)            | 0.07 – 6.75   |
| Helminthosis + Babesiosis + Tick Infestation + Trypanosomosis | 1 (1.41)            | 0.07 – 6.75   |

**Table 5. Prevalence of parasitic diseases coinfection of monkeys among the various epidemiological factors in Osun State, Nigeria (2006-2015).**

| Variables | N  | Number (%) of parasitic diseases (co-infection) |            |            |          |
|-----------|----|-------------------------------------------------|------------|------------|----------|
|           |    | 1                                               | 2          | 3          | 4        |
| Age       |    |                                                 |            |            |          |
| Young     | 24 | 0 (0.00)                                        | 20 (83.33) | 4 (16.67)  | 0 (0.00) |
| Adult     | 47 | 17 (36.17)                                      | 19 (40.42) | 10 (21.28) | 1 (2.13) |
| Gender    |    |                                                 |            |            |          |
| Male      | 48 | 8 (16.67)                                       | 32 (66.66) | 8 (16.67)  | 0 (0.00) |
| Female    | 23 | 9 (39.13)                                       | 7 (30.43)  | 6 (26.09)  | 1 (4.35) |
| Season    |    |                                                 |            |            |          |
| Wet       | 47 | 17 (36.17)                                      | 25(53.19)  | 5 (10.64)  | 0 (0.00) |
| Dry       | 24 | 0 (0.00)                                        | 14 (58.33) | 9 (37.50)  | 1 (4.17) |

Helminthosis was the most diagnosed parasitic disease in this study, and this finding is not novel as 100% of vervet monkeys (*Cercopithecus aethiops*) studied by Egbedade *et al.* [4] were infected with helminths. Similarly, a 100% prevalence of helminth infections were respectively recorded among green monkeys (*Chlorocebus sabaeus*), mandrill monkeys (*Papio leucophaeus*) and mangabey monkeys (*Cercocebus torquatus*) [3]. The high prevalence of helminthosis recorded here may be attributed to lack or inadequate veterinary attention and inadequate hygienic measures under which the animals were raised.

**Table 6. Spearman's correlation coefficient ( $r_s$ ) for the co-occurrence of parasitic diseases infecting monkeys in Osun State, Nigeria (2006-2015).**

|                        | Hel      | Bab      | TI      | Mya    | LI     | Mange  | FI     | Tryps |
|------------------------|----------|----------|---------|--------|--------|--------|--------|-------|
| Helminthosis (Hel)     | 1.000    |          |         |        |        |        |        |       |
| Babesiosis (Bab)       | -0.631** | 1.000    |         |        |        |        |        |       |
| Tick infestation (TI)  | -0.491** | 0.587**  | 1.000   |        |        |        |        |       |
| Myiasis (Mya)          | -0.092   | -0.002   | -0.145  | 1.000  |        |        |        |       |
| Lice infestation (LI)  | 0.203    | -0.322** | -0.232  | -0.095 | 1.000  |        |        |       |
| Mange                  | 0.193    | -0.306** | -0.296* | 0.297* | -0.193 | 1.000  |        |       |
| Flea infestation (FI)  | -0.196   | 0.028    | 0.134   | -0.075 | -0.161 | -0.029 | 1.000  |       |
| Trypanosomosis (Tryps) | 0.054    | 0.167    | 0.173   | -0.025 | -0.054 | -0.051 | -0.043 | 1.000 |

\*\*Correlation is significant at the 0.01 level (2-tailed), \* Correlation is significant at the 0.05 level (2-tailed).

Higher prevalence of helminthosis was observed in young compared to adult monkeys. In tandem with our finding, Mbaya and Udendeye [9] reported higher prevalence of helminth infection in young than adult monkeys in Calabar, Nigeria. This could be due to higher susceptibility of the young, naïve monkeys to the infection [3,18]; suggesting that helminth infections usually occur more frequently at early ages in monkeys.

The higher prevalence of babesiosis and tick infestation seen in adult compared to the young monkeys in our study appears interesting as the reverse was reported by Springer *et al.* [5] among wild Malagasy primates in Madagascar. Babesiosis is associated with premunition and this might explain the lower prevalence of the condition in young monkeys. In addition, parent monkeys take time to groom their young ones which might lead to reduction in tick infestation and thus lower prevalence of babesiosis in the young.

The significantly higher prevalence of babesiosis recorded in female than male monkeys is similar to the observations of Jeneby [8] that male baboons were more prone to *Babesia microti* infection than their female counterparts. Babesiosis appears to be more common during the dry season than the wet season. The opposite would have been expected as the ticks, which are vectors of the agent causing babesiosis, are more abundant during the wet season than the dry season [24]. Although tick infestation appears to be more during the wet season, the manifestation of the diseases they transmit may occur during the dry season, as the incubation period of babesiosis is about 6 weeks [21].

The coinfection dynamics showed that about 76% of the studied monkeys were infected with multiple parasitic conditions and this cuts across age, gender and seasons. Co-infection by multiple parasites species is a common occurrence among animals [25] including monkeys. The moderate and positive correlation between babesiosis and tick infestation is expected as ticks (*Haemaphysalis spinigera*) are the known vectors of *Babesia* (*Babesia microti*) to monkeys [5,20,21].

## CONCLUSION AND RECOMMENDATIONS

Eight parasitic disease conditions were diagnosed among monkeys in the study area, with helminthosis, babesiosis and tick infestation being the most prevalent. Some of the parasites

encountered during the study may have zoonotic implications for people who handle or use monkeys as pets, research subject, recreation and entertainment animals. It is therefore recommended that people should exercise caution and proper hygiene in their relationship with the animals to reduce the risk of transmission of infection between animals and man. Adequate and prompt veterinary and medical attention is needed to curb this menace for the benefit of the studied animal species and man. Public education and awareness on the possible zoonosis from animals and periodic screening and treatment against parasites is further recommended for such animals and incontact individuals.

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